

## ***Using the ADS7869 for Motor Control Demo Board***

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### **ABSTRACT**

This application report describes the characteristics, operation, and use of the ADS7869 for the Motor Control Demo Board. This board is used as part of the demonstration materials for the Digital Motor Control Seminar presented by Texas Instruments. A complete circuit description and schematic diagram are included.

### **1 Related Documentation from Texas Instruments**

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**Data Sheets:**

ADS7869

OPA353

AM26LS31

**Literature Number:**[SBAS253](#)[SBOS103](#)[SLLS114](#)**Application Reports:**

Designing Modular EVMs for Data Acquisition Products

[SLAA185](#)

Data Converters for Industrial Power Measurements

[SBAA117](#)**Additional Technical Documents:**

5-6K Interface Board

[SLAU104](#)

HPA-MCU Interface Board

[SLAU106](#)

## 2 EVM Overview

### 2.1 Features

- Encoder connections to A1/A2 and B1/B2
- 3-Phase Current Inputs to IU, IV, and IW
- Access to additional five analog inputs provided
- SPI mode supported on TMS320x28xx™ and TMS470™ series controllers when used with the HPA-MCU Interface Board
- SPI mode supported on TMS320C5000™ and TMS320C6000™ series DSPs when used with the 5-6K Interface Board

## 3 Introduction

This application report describes the characteristics, operation, and use of the ADS7869 for the Motor Control Demo Board. A complete circuit description and a schematic diagram are included. This demonstration board is used with a 3-phase brushless servo motor from Parker Automation and a sinusoidal encoder from Heidenhain. The system monitors three of the phase currents through current transducers from LEM, as well as position information from the encoder. The Code Composer Studio™ software associated with the demonstration platform monitors and displays current and position information through the DSP host processor.

The ADS7869 for Motor Control Demo Board takes advantage of the DAP Modular EVM form factor (described in document [SLAA185](#)) which provides direct plug-in compatibility with all current C5000™ and C6000™ series DSKs from Texas Instruments and Spectrum Digital when used with the 5-6K Interface Board ([SLAU104](#)). TMS470, MSP430, and C2000™ series controller users can use the demo board with the HPA-MCU Interface Board [SLAU106](#).

## 4 Analog Interface

The ADS7869 Motor Control Demo Board is designed for easy interfacing to multiple analog sources. Two-position screw terminals J8, J9, and J11 provide convenient access to the ADS7869 IV, IU, and IW input pins. By default, the EVM has resistor/capacitor combinations intended for differential mode signals.

Two sinusoidal encoder inputs are provided via 12-pin, 2-mm shrouded headers J12 and J13. J12 provides access to the A1 and B1 differential inputs of the ADS7869. Resistor/capacitor combinations are provided to allow differential-mode signals to be applied directly to the ADS7869. A comparator circuit is used on the J12 connector to provide an index pulse from the encoder. The index pulse, along with the A1 and B1 comparator outputs from the ADS7869, are passed through an AM26LS31 quadruple line driver. The ANSI TIA/EIA-422-B compatible outputs of the AM26LS31 are provided for use as a quadrature feedback to the controller unit via 12-pin, 2-mm shrouded header J1.

J13 provides access to the A2 and B2 inputs of the ADS7869. Resistor/capacitor combinations are also used to allow differential mode input signals. Dual-operational-amplifier footprints are included on both the J12 and J13 signal paths to provide addition signal amplification, if necessary. [Table 1](#) provides the pinout for both J12 and J13.

**Table 1. J12/13 - Sinusoidal Encoder Connectors**

PIN NUMBER	SIGNAL	DESCRIPTION
1, 2	+5V	Encoder power
3	Z1-	Pin 3 – Index(-)
4	Z1+	Pin 4 – Index(+)
5	COS-	Pin 5 –COS(-)
6	COS+	Pin 6 – COS(+)
7	SIN-	Pin 7 –SIN(-)
8	SIN+	Pin 8 – SIN(+)
9, 10	SHIELD	Optional shield connections
11, 12	GROUND	Encoder ground

## 5 Digital Interface

The ADS7869 Motor Control Demo Board is designed for easy interfacing to multiple control platforms. Samtec part numbers SSW-110-22-F-D-VS-K and TSM-110-01-T-DV-P provide a convenient 10-pin, dual-row header/socket combination at J15 and J16. This header/socket combination provides access to the digital control and serial data pins of the ADS7869. [Table 2](#) and [Table 3](#) provide the list of signals found on J15 and J16

**Table 2. J15 - Serial Data Interface**

PIN NUMBER	DSP SIGNAL	DESCRIPTION
1, 2, 6, 8, 12, 14, 16, 17, 19, 20	Unused	No connections
3, 5	SPICLK	SPI (Burst Mode) Serial Clock
7, 9	SPISTE	SPI Slave Transmit Enable (Frame Sync)
11	SPISIMO	SPI Slave In Master Out (Dx)
13	SPISOMI	SPI Slave Out Master In (Dr)
15	DAV	Data Available – Used as an external interrupt source to the host processor
4,10,18	N/A	Digital ground connections

**Table 3. J16 - Serial Control Interface**

PIN NUMBER	DSP SIGNAL	DESCRIPTION
1	RST	GPIO signal from host - Used as hard RESET on the ADS7869
2,5,6,8,9,11-14, 16, 17, 19, 20	Unused	No connections
3	CLK	System Clock Input
7	HOLD1/2	
15	INT#	INT – Used as an external interrupt source to the host processor
4,10,18	N/A	Digital ground connections

## 6 Power Supplies

The ADS7869 for Motor Control Demo Board requires +5 Vdc for analog and +3.3 to +5 Vdc for the digital sections of the ADS7869. When used in combination with the 5-6K or HPA-MCU Interface Boards, J19 (located on the bottom side of the PWB) provides connection to the common power bus described in document [SLAU104](#) and [SLAU106](#) for use with the analog and digital portions of the board (see [Table 4](#)).

When used as a stand-alone EVM, two-position screw terminals J3 and J10 provide an alternate means of applying the required operating voltages. +5 Vdc to the analog sections of the board can be applied to J3, while the +3.3 to +5 V digital supplies can be applied to J10. Filters are provided for all power supply inputs; however, optimal performance of the EVM requires a clean, well-regulated power source.

**Table 4. J19 – Power Supply Connections**

PIN NUMBER	Voltage	DESCRIPTION
3	+VAin	Analog +5V supply
5	AGND	Analog supply ground
6	DGND	Digital supply ground
9	+3.3VD	+3.3V Digital – Used with W6
10	+5VD	+5.0V Digital – Used with W6
1,2,4,7,8	N/A	Unused on this EVM

## 7 EVM Operation

The analog input source to the IU, IV, and IW inputs of the ADS7869 can be applied directly to J8, J9, and J11. Note the polarity on the silkscreen for proper signal connections. The analog voltage input range for the ADS7869 is limited to  $\pm 0.3$  V about the analog supply voltage. For demonstration purposes, the voltage applied at these terminals is derived from off-board current sensors which contain all necessary level shifting and voltage limiting for direct connection to the ADS7869 inputs. When used outside the demonstration platform, care should be taken to ensure that the applied voltages are within the ranges specified in the data sheet. [Table 5](#) shows the 3-phase current input connections to IU, IV, and IW.

**Table 5. 3-Phase Current Inputs**

PIN NUMBER	Signal	DESCRIPTION
J8.1	IVN	Negative Input – Phase V Current
J8.2	IVP	Positive Input – Phase V Current
J9.1	IWN	Negative Input – Phase W Current
J9.2	IWP	Positive Input – Phase W Current
J11.1	IUN	Negative Input – Phase U Current
J11.2	IUP	Positive Input – Phase U Current

The encoder signals should be applied to J12 or J13, following the signal pattern shown in [Table 1](#). For convenience, test points are located beside J12 and J13 for direct connection of signals from a variety of sources. The encoder used in the demonstration platform is a Heidenhain model ROD 486 with 1024 lines. The output signals from this device are sine, cosine, and index at 1 Vpp (about +2.5 V) which are fed directly to the inputs of the ADS7869. When used outside the demonstration platform, care should be taken to ensure that the applied voltages are within the ranges specified in the data sheet.

The digital control signals can be applied directly to J15 and J16 (top or bottom side) making it compatible with nearly any microcontroller, DSP, or FPGA controller. The ADS7869 for Motor Control Demo Board can also be connected to a TI DSP or microcontroller by means of the 5-6K Interface Board or HPA-MCU Interface Board as mentioned previously. Connector J4 is provided for stability and the possibility of adding an external reference source to the board.

The SIN/COS sign comparator outputs from the ADS7869 are available on J5 and J14 and can be used with the encoder to create quadrature output pulses via U4. The current sign and limit outputs from the ADS7869 are available on connectors J6 and J7. The DAC output and input signals are also available on W2.

Two additional connectors (J2 and J18) provide +5-V analog power and the 2.5-V reference voltage to external boards as needed. On the demonstration platform, J2 provides +5 V to operate the current sensors. J18 provides the +2.5-V reference output from the ADS7869 to act as a common mode voltage for the current outputs.

## 8 ADS7869 Reference Bill Of Materials

Table 6 lists the ADS7869 reference design EVM bill of materials. The Gerber files and Code Composer Studio™ software used on the demonstration platform are available for download from the Texas Instruments Web site at <http://www.ti.com>. Use the keyword search, and follow the links for document number [SLAA231](#).

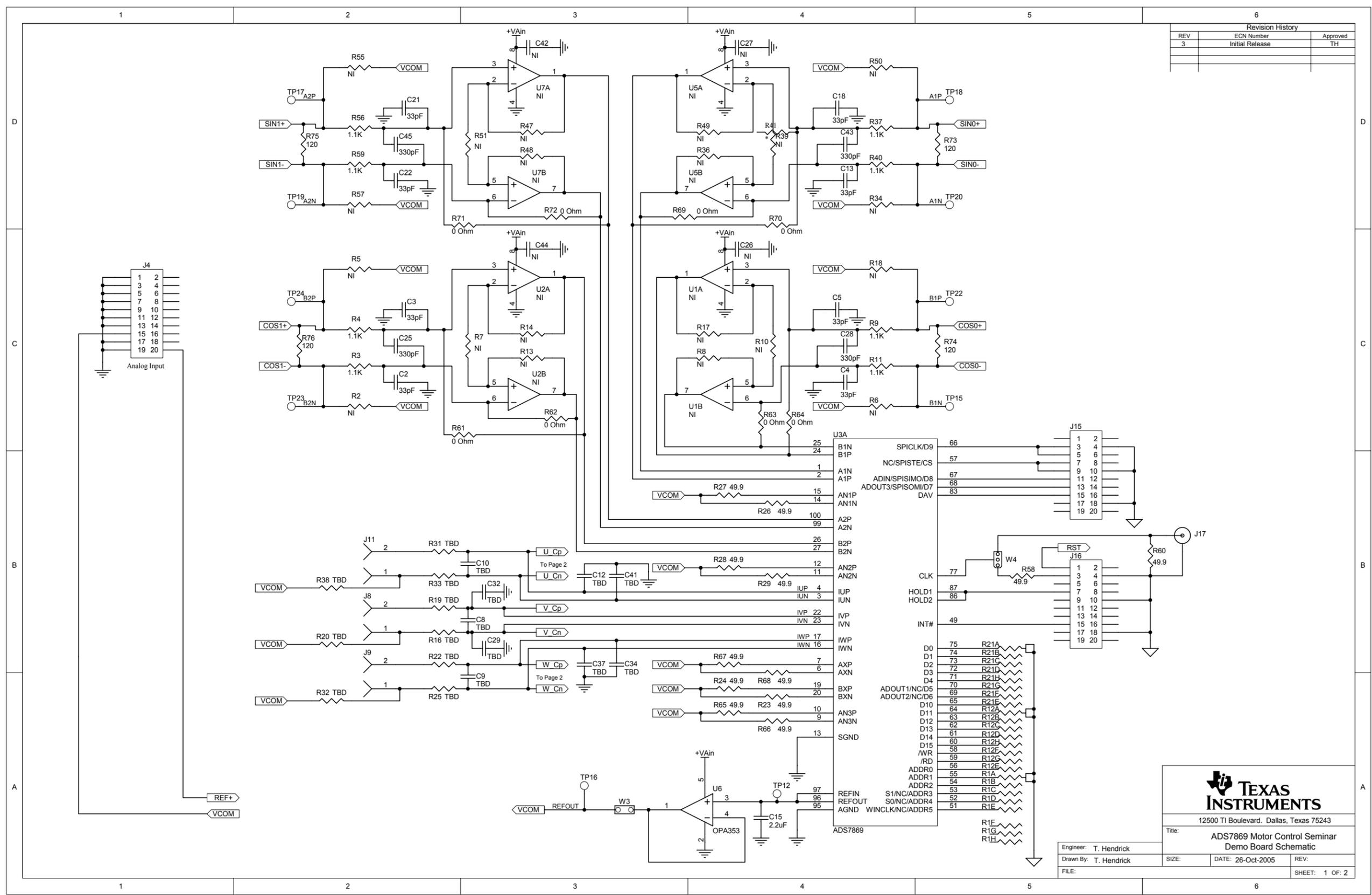
**Table 6. Bill of Materials**

DESIGNATORS	DESCRIPTION	MANUFACTURER	MFG PART NUMBER
C1 C6 C7 C16 C17 C24 C35 C36	10µF, 1210, Ceramic, X7R, 10V, 10%	AVX	1210ZC106KAT2A
C2 C3 C4 C5 C13 C18 C21 C22 C23	33 pico F, 0805, Ceramic, C0G, 50V, 5%	AVX	08055A330JAT2A
C11 C19 C30 C31 C33 C38 C39 C40	0.1µF, 0805, Ceramic, X7R, 50V, 10%	AVX	08055C104KAT2A
C14 C25 C28 C43 C45	330 pico F, 0805, Ceramic, C0G, 50V, 5%	AVX	08055A331JAT2A
C15	2.2µF, 1206, Ceramic, X7R, 10V, 10%	AVX	1206ZC225KAT2A
D1 D3	1206 Size SMT LED – Amber	Chicago Miniature	7010X7
J2 J3 J8 J9 J10 J11 J18	2 Terminal Screw Connector	Off Shore Technologies	ED1514
J4 J15 J16 (top side)	10 Pin, Dual Row, SMT Header (20 Pos.)	Samtec	TSM-110-01-T-DV-P
J4 J15 J16 (bottom side)	10 Pin, Dual Row, SMT Socket (20 Pos.)	Samtec	SSW-110-22-F-D-VS-K
J5 J14	2 Pin, Dual Row, 2mm Header	Norcomp	2164-72-01-P2
J6 J7	6 Pin, Dual Row, 0.1" Header	Samtec	TSW-103-07-L-D
J12 J13 (from bottom side)	6 Pin, Dual Row, 2mm Shrouded Header, RA	Molex/Waldom	87333-1220
J17	SMA Through Hole Connector	Johnson	142-0701-231
J19 (bottom side)	5 Pin, Dual Row, SMT Socket (10 Pos.)	Samtec	SSW-105-22-F-D-VS-K
L1 L2	4.7 µH Inductor	Inductor Warehouse	BNX002-01
R1 R12 R21	Bussed 8 Element 10K Ω	Panasonic	EXB-A10P103J
R3 R4 R9 R11 R35 R37 R40 R42 R54 R56 R59	0805 Size, 1%, 1.1K Ω	Yageo America	9C08052A1101FKHFT
R15 R16 R19 R22 R25 R30 R31 R33 R43 R61 R62 R63 R64 R69 R70 R71 R72	0805 Size, 5%, 0.0 Ω	Yageo America	9C08052A0R00JLHFT
R23 R24 R26 R27 R28 R29 R58 R60 R65 R66 R67 R68	0805 Size, 1%, 49.9 Ω	Yageo America	9C08052A49R9FKHFT
R41 R44 R45 R46 R53	0805 Size, 5%, 10K Ω	Yageo America	9C08052A1002JLHFT
U3	ADS7869	Texas Instruments	ADS7869IPTZR
U4	AM26LS31	Texas Instruments	AM26LS31CD
U6 U8	OPA353	Texas Instruments	OPA353NA/250
TP2 TP12 TP13 TP16	Red Test Point Loop	Keystone	5000
TP1 TP11	Black Test Point Loop	Keystone	5001
W1W5	2 Pin, Single Row, 0.1" Header	Samtec	TSW-102-07-L-S
W2 W3 W7	2 Pin, Single Row, 2mm Header	Norcomp	2163-36-01-P2
W4 W6	3 Pin, Single Row, 0.1" Header	Samtec	TSW-103-07-L-S

## **9 ADS7869 Reference Design Schematic**

The schematic for the ADS7869 Reference Design is included in the following pages.

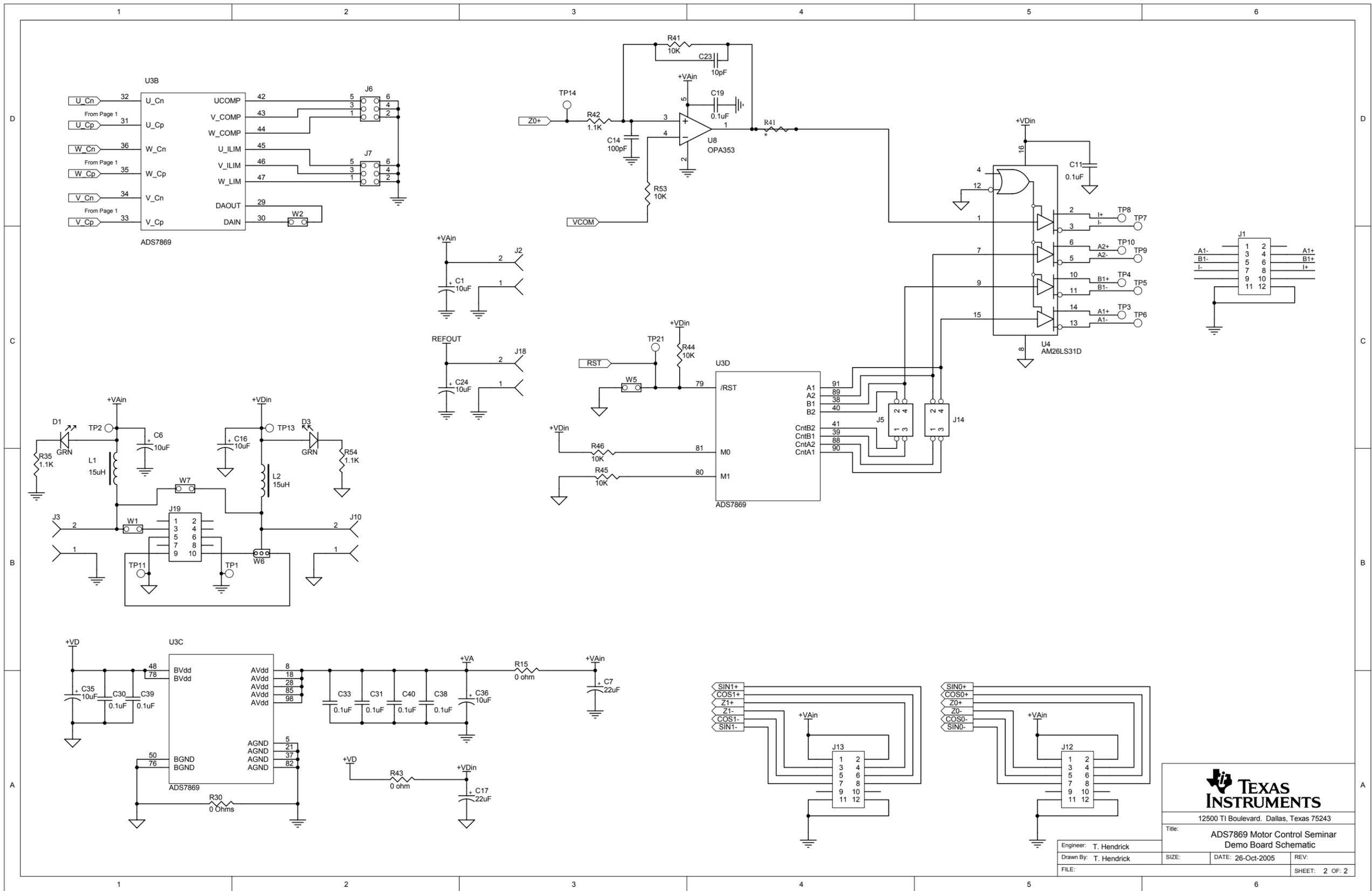
Revision History		
REV	ECN Number	Approved
3	Initial Release	TH



**TEXAS INSTRUMENTS**  
 12500 TI Boulevard, Dallas, Texas 75243

Title: ADS7869 Motor Control Seminar Demo Board Schematic

Engineer: T. Hendrick  
 Drawn By: T. Hendrick  
 DATE: 26-Oct-2005  
 SHEET: 1 OF 2



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